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LUNG INFECTION DETECTION USING COUGH SOUNDS

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Abstract: Regardless of age, pulmonary infections are a big challenge throughout the world which may lead to huge number of deaths in every year. It is necessary to identify the lung diseases in early stages so that doctors can help the infected person. In existing system, so many deep learning algorithms have been used to find out pulmonary diseases using cough sounds, but have not given much accurate results. The main intention of this publication is to raise awareness among people about lung infections in advance with the help of cough sounds. The system, called RESNET-18, uses a deep learning algorithm to analyse and categorize cough sounds. By listening to cough sounds, one can determine whether a person may be suffering from pneumonia, pulmonary edema, asthma, TB, COVID-19, pertussis, or another respiratory illness. It offers a safe and economical way to determine the likelihood lung infections.

Keywords: Audio Processing,Deep Learning Algorithms, Cough-Based Diagnosis, Respiratory Ailment Diagnosis, ResNet-18 algorithm.

1. INTRODUCTION

As a global health concern, respiratory disorders necessitate prompt detection. In order to replace harmful diagnostic methods, this research investigates the application of lung infections. Pulmonary disorders range from mild illness to life-threatening infections, and prompt diagnosis is essential for appropriate treatment. The traditional method has people see medical specialists, which causes delays in diagnosis, higher expenses, and restricted accessibility in disadvantage areas. Convolutional techniques for diagnosing lung disorders frequently entail intrusive treatment, such X-rays and certain other testes, which might not be feasible in every situation. The occurrence of new technology like deep learning plays a vital role in problem solving. Mainly CNN, which presents an opportunity for the creation of effective and painless diagnostic instruments.

1.1 DEEP LEARNING:

When computers were discovered, researchers and scientists thought about the possibility that one day machines would think like humans. And that came true. Here we are in a modern world where machines think like humans and work more accurately on complex data, where sometimes humans make mistakes. They learn from their previous experiences and knowledge of their surroundings by interacting. They also compare the given data with their previous data or previous outputs for better and more accurate results. Here, it requires less human effort.

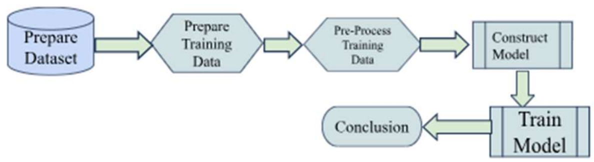

Fig.1.Deep Learning Workflow

1.2 ResNet–18: A kind of CNN architecture, ResNet-18 is a member of the ResNet (Residual Networks) family. The usage of residual blocks is the main innovation in ResNet.

Shortcut connections, also known as skip connections, that evade one or more layers are included in residual blocks. This facilitates the learning of residual functions by the network, hence easing the training of very deep network. Residual connections aid in developing deeper neural networks and alleviate the vanishing gradient problem.

1.3 Audio Classification: We can view this application as the "Hello World" of audio deep learning, much as the classification of handwritten digitals using the MNIST dataset is regarded as a "Hello-World" – type challenge for Computer Vision. First, sound recordings will be used, which will then be transformed into spectrograms and fed into a CNN plus linear classifier model to generate predictions regarding the class to which the sound belongs.

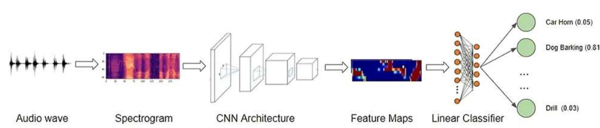

Fig.2 Audio Classification Application

2. LITERATURE REVIEW:

The paper "Estimation of Respiratory Rate from Breathing Audio" [1] outlines a machine learning technique that use spectrogram representation of audio signal and tagged data for breathing cycles. They are able to achieve better results and accuracy compared to traditional methods, and there are fewer errors or deviations compared to normal methods. To alleviate the shortage of publicly available datasets, they propose a unique technique for data augmentation that expands the effective size of the accessible dataset. This data augmentation method makes use of continuous-time signals to generate other kinds of similar signals so that they can be trained on data for better accuracy.

The recent publication [4] outlines the machine learning technique that uses the CNN approach for better results in radiography. The diseases, mainly TB and pneumonia, are identified and classified based on the radiography. When compared to other approaches, the specific method provides better accuracy and early detection. The radiography images are trained on the various collected datasets and then compared to other different systems to see if better accuracy is reached or not. They trained and applied three deep learning models: the transfer, functional, and sequential models. With the help of these models, they can detect diseases more quickly, identify potential remedies more accurately. One of the finest approaches in terms of better accuracy, based on the tasks performed and the results that were obtained.

The study [5], which was one of the most innovative and phenomenal research projects based on the recent pandemic situation faced by people around the globe. We know how COVID-19 changed our faith by affecting our health. Through this innovative approach, it became easy for people to check coronavirus symptoms based on cough audiotapes. The use of ResNet-50 in parallel with the CNN to train cough records with the MIT open-source voice system dataset. The dataset consists of both COVID-positive cough symptoms and COVID-negative cough symptoms. This whole process is made possible with the help of a cell phone tape AI speech processing system. During pre-processing, a spectrogram is used for a clearer and better result.

[6] The study “Cough Detection Algorithm for Monitoring Patient Recovery From Pulmonary Tuberculosis” deals with the challenges associated with TB diagnosis and treatment. Throughout the world, tuberculosis (TB) is the commonest disease and the huge issue is the lack of dedicated laboratories. A non-laboratory method to monitor a patient progress during treatment will be very helpful. It Introduce the importance of checking patient curing and the role of cough as a crucial symptom in TB identification and treatment. Implemented machine learning algorithms and signal processing techniques like Mel-Frequency Cepstral Coefficients (MFCC) for speech and audio processing, including cough detection tasks. MFCCs depict the essential characteristics of sound signal in representation fit for analysis and classification tasks. They showed experimental data which propose decrease in cough frequency in persons who respond well to medication.

[8] The study “Cough Sound Analysis for Diagnosing Croup in Pediatric Patients Using Biologically Inspired Features” aims to research the ability of using cough sound as a diagnostic tool for identifying croup (a common respiratory illness) in children. They collected the sound recordings from diagnosed with croup and without. The collected recordings are then broken down using biologically inspired features (taken from the understanding of auditory processing system in the human auditory system). These are aimed to take specific characteristics of cough sounds that may be typical of croup. They have used spectral and temporal modulation analysis techniques for feature extraction and Support Vector Machines (SVM), K-Nearest Neighbors (KNN) for classification and diagnosis based on extracted biologically features. Overall, the study promotes the research on usage of sound analysis methods for medical diagnosis.

[9] The study “Detection of Tuberculosis by Automatic Cough Sound Analysis” addresses the ability of using automatic cough sound analysis as diagnostic tool for detecting tuberculosis (TB). TB is the major global health concern, and early detection is very important for better treatment of the disease. This study delve into a direct and user-friendly TB testing technique based on automated evaluation of cough sounds. Support Vector Machines (SVM), K-Nearest

Neighbors (KNN) or neural networks are used to differentiate between cough sounds to that of tuberculosis and those from healthy individuals. The paper delivers to field of TB diagnosis by researching the probable of automatic cough sound analysis as non-invasive, cost-effective method for potential early detection and treatment outcomes.

3. PROPOSED SYSTEM

This technology uses cough sounds to identify lung illnesses by utilizing deep learning and cutting edge technologies. The system provides a web interface for users to upload cough audio files. The uploaded audio is processed to generate a Mel spectrogram, which is then passed on to a pre-trained neural network model (ResNet-18) for prediction. The results are displayed on a webpage along with a pie chart visualizing the likelihood of positive and negative predictions.

3.1 ADVANTAGES

- The system aims to detect lung infections early by analysing the cough sounds.
- The quick screening provided by the smart tool allows for timely identification of lung infections, enabling individuals to take necessary actions immediately.
- The analysis of cough noises is automated through the use of a deep learning algorithm (ResNet-18), which makes the procedure reliable and efficient. By using a dataset as a learning tool, the system becomes more accurate at recognizing patterns linked to lung illnesses.

3.2 METHODOLOGY

3.21 Data Collection

To build a thorough dataset, we collect cough sounds from different sources, including persons with having lung infections and a group of healthy persons. Data collection from various locations and individuals helps in differentiating the cough sounds connected with respiratory conditions. The collected data turn out into training data for the deep learning model

3.22 Preprocessing

During preprocessing, the data is transformed into a spectrogram, which is a graphic depiction of the intensity of cough sounds over time at different frequencies. The neural network (ResNet-18) is trained using the features extracted from audio data via the spectrogram. Filter banks and the signal processing tool for time frequency analysis (STFT) are used to transform audio input into spectrograms. In order to facilitate efficient deep learning analysis, this preprocessing of the acquired data is done to eliminate noise and undesired information.

3.23 ResNet-18 Architecture

ResNet-18 architecture is selected for its recognition of its performance in image and audio classification tasks. ResNet-18 is a deep convolutional neural network distinguished by its residual blocks, allowing the training of deeper networks and modifying the issues like vanishing gradients. This architecture is trained for the analysis of cough sound spectrograms:

- **Input Layer:** Spectrogram are taken as inputs, recording both temporal and frequency features of cough sounds.
- **Convolution Layer:** Multiple convolutional layers having small filter sizes are used to record structured features within the spectrogram.
- **Residual Blocks:** Residual blocks are a characteristic feature of ResNet architecture. Each block contains skip connections, allowing the input to avoid one or more layers. This simplifies the flow of information through the network, allowing the model to learn multiple patterns associated with lung infections.
- **Global Average Pooling:** Pooling is done to compress the spatial dimensions and extract important features for classification.
- **Fully Connected Layers:** The final layers complete the classification based on the learned features, and it outputs the probability of having a lung infection.

3.24 Training The Model

The model is trained using a suitable optimization technique. As we know, overfitting is a drawback for the prepared model, so to avoid overfitting, here we are training with the known dataset. This helps us understand its behavior with new datasets. It is done by tracking performance on the dataset while we train. Here are some important metrics that define the behavior of a model, like accuracy, recall, and precision. Comparisons with existing methods are done in order to judge the overall perfection and performance of the offered strategy. To verify the model's accuracy and behavior over a range of data subclasses, cross-validation techniques are taken into consideration

4. RESULTS AND DISCUSSION

With the collected samples, we trained on our dataset, where we got more accuracy compared to other traditional methods. It is major advantage is no cost and less time. We can say that it is a potential method for early identification of lung diseases compared to the remaining methods. It gives a clear and accurate output, as the infection is negative if there are no symptoms. It is a very friendly tool to handle for patients. They can check there symptoms remotely and consult a doctor based on their requirements. They can monitor their health regularly through our flask deployment**.**

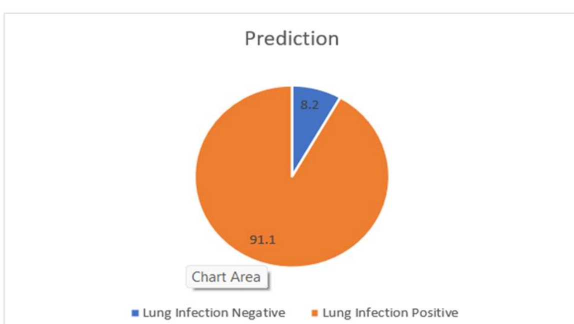

Fig.3: Cough is Lung Infection Positive. It is recommended to consult doctor.

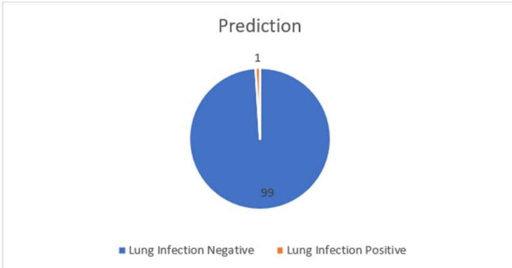

Fig. 4: Cough is Lung Infection Negative, but monitor your health.

5.CONCLUSION and FUTURE SCOPE

In conclusion, the incorporation of deep learning into the analysis of cough audio data represents a fundamental change in the diagnosis of lung infections. This approach, with its user friend web interface, Mel spectrogram generation, and ResNet based prediction model, offers innovative solution to the challenges related with traditional diagnostic processes. By decreasing time and cost, improving approachability, and providing pain free alternative, this innovation has the possibility to reshape the conditions of pulmonary health diagnostics.

As we are at the convergence of healthcare and technology, this idea serves as example of progress. The approach holds the possibility of improving patient outcomes and decreasing the worldwide trouble of respiratory diseases. The path toward meaningful clinical impact requires sustained commitment to rigorous validation, ethical considerations, and collaborative efforts across interdisciplinary domains. Continuous improvement of the ResNet-18 modal, searching of substitute architectures, and merging of multi-modal data could improve the accuracy and trustworthy of lung infection detection.

Future work involves a multidimensional method, including technological development, progression of diagnostic capabilities, and global collaboration. By being there at the leading place of research and technology, the approach can grow into a comprehensive and essential tool in the scope of respiratory health, offering advantages to individuals, healthcare providers, and the healthcare ecosystem as a whole.

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